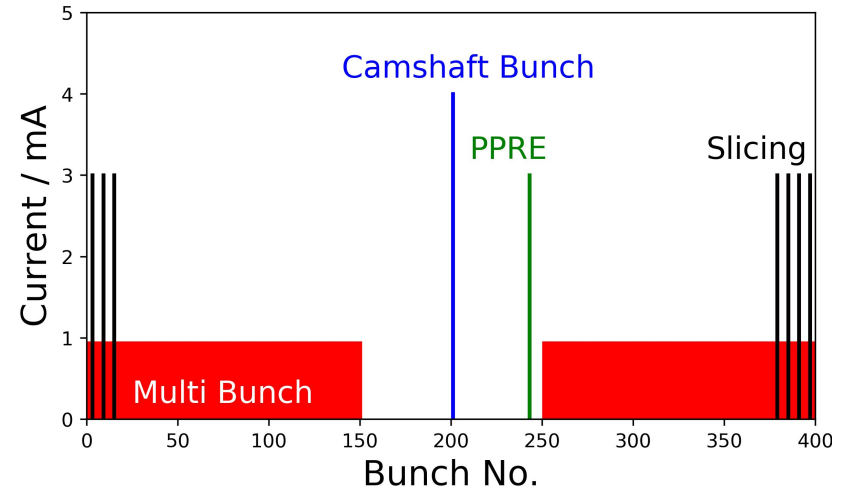


Bunch-Resolved 2D Diagnostics - Streaking Combined with Interferometry

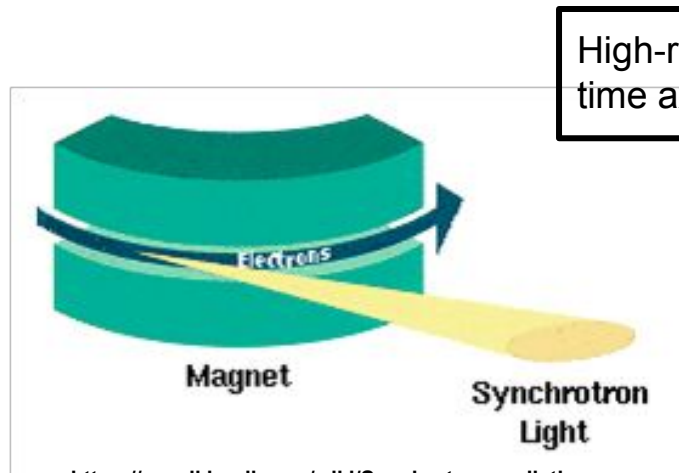
Marten Koopmans, J.-G. Hwang,
A. Jankowiak, M. Ries, G. Schiwietz

- Complex standard user fill pattern, with different bunch properties
 - Bunch Current
 - **Transverse** beam size
 - Bunch **length**
- Short pulses in low-current low- $\alpha \approx 1$ ps
- Future Parameters of a possible Variable Pulse Length Storage Ring (VSR) would be even more demanding



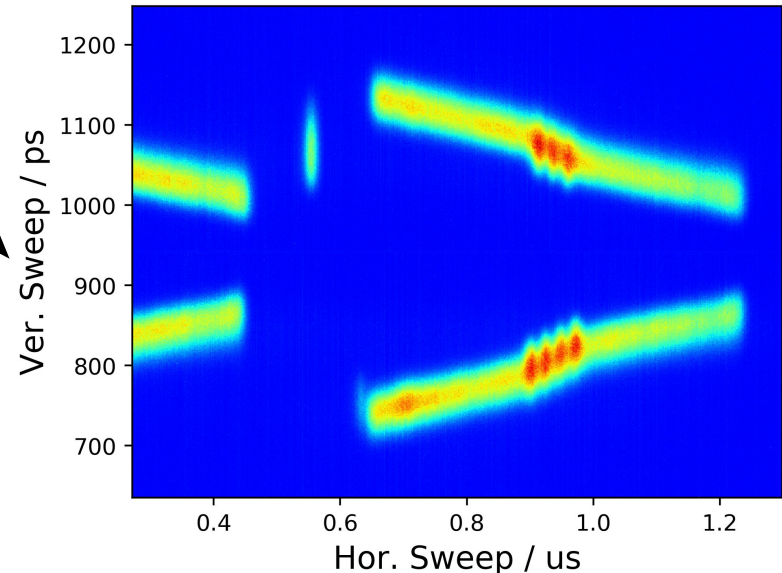
➔ **Bunch resolved diagnostics is needed**

- New longitudinal diagnostics dipole beamline with visible synchrotron light commissioned and in operation since beginning of 2020
- New Hamamatsu Fast Streak Camera C10910 with improved resolution ($<1\text{ps}$) for short bunches at BESSY II, possible short VSR bunches and very high repetition rate (1kHz)

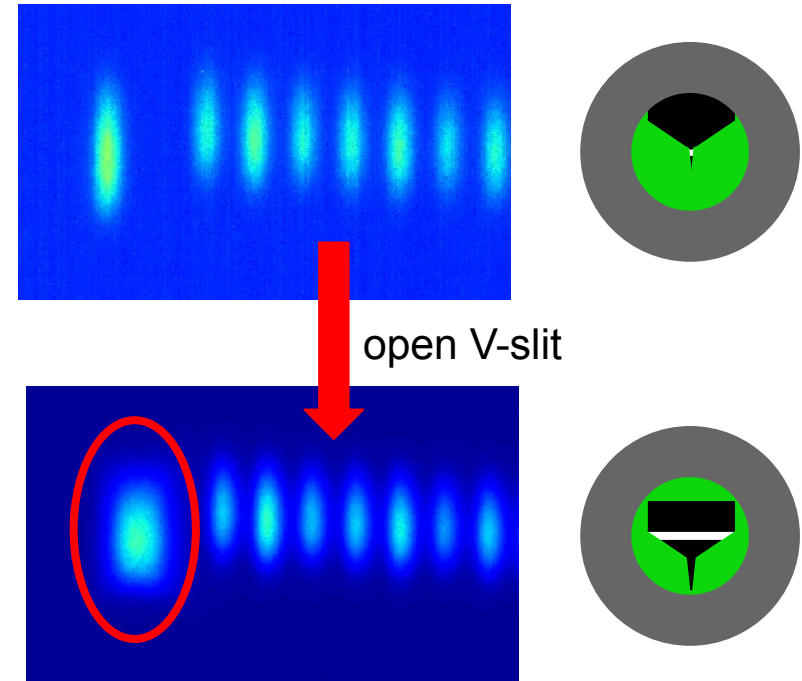
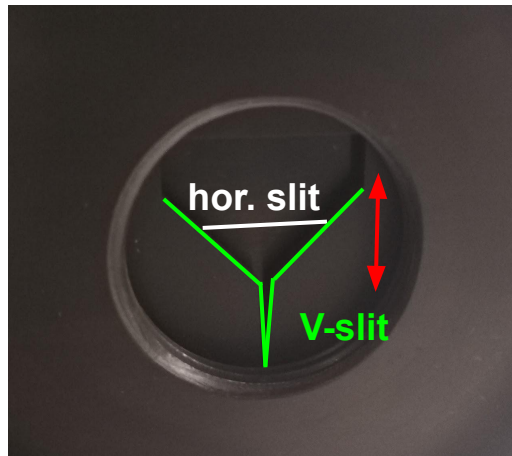


https://en.wikipedia.org/wiki/Synchrotron_radiation

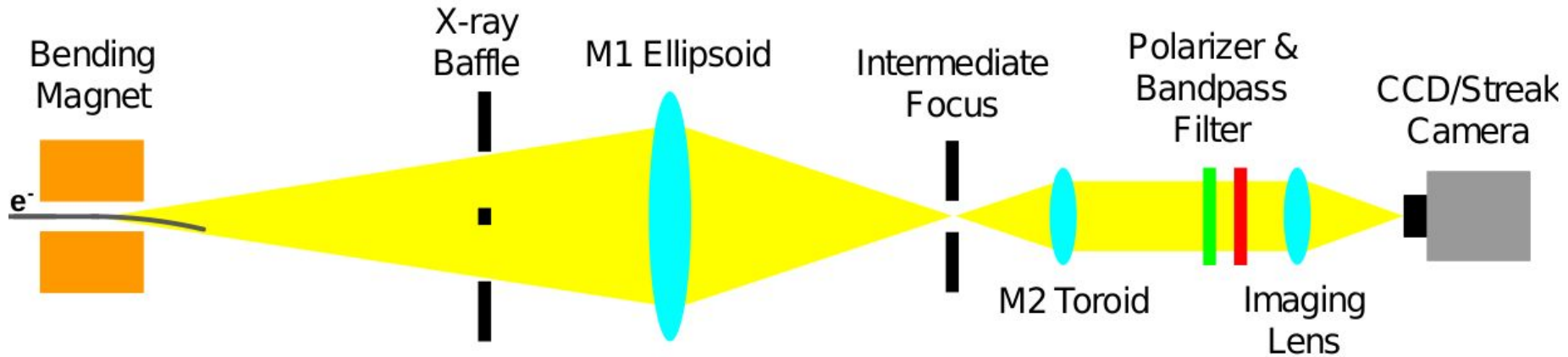
High-res.
time axis



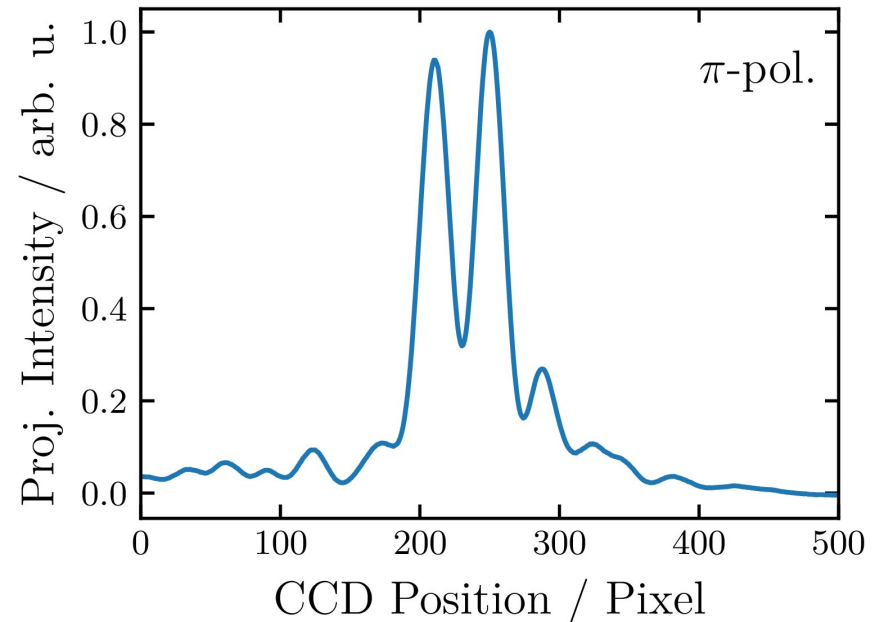
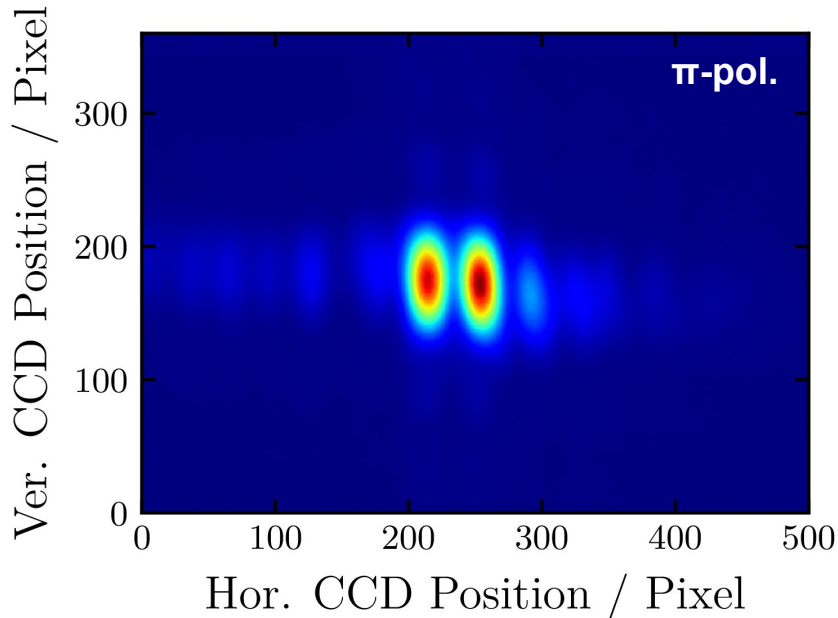
- Good imaging properties at beamline
 - Wide streak camera aperture
(V-shaped slit)
- ⇒ Additional transverse bunch size measurement with streak camera



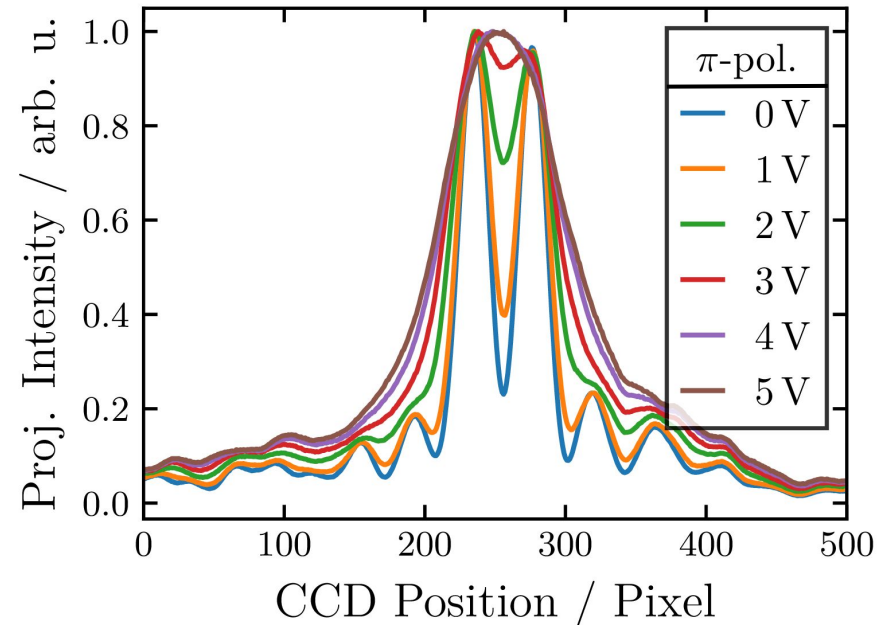
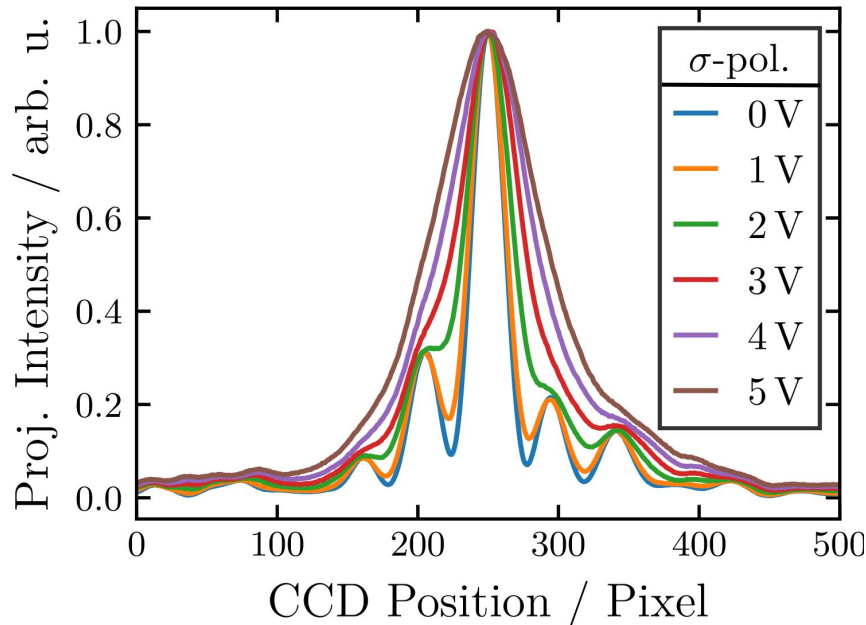
- Capable of transverse diagnostics, but diffraction / resolution limited
- RMS Resolution of beamline + streak camera 120 μm (hor.) and 180 μm (ver.)
- Combination of interferometric methods with streak camera?
- Use the X-ray blocking baffle for interferometric measurements in vertical direction



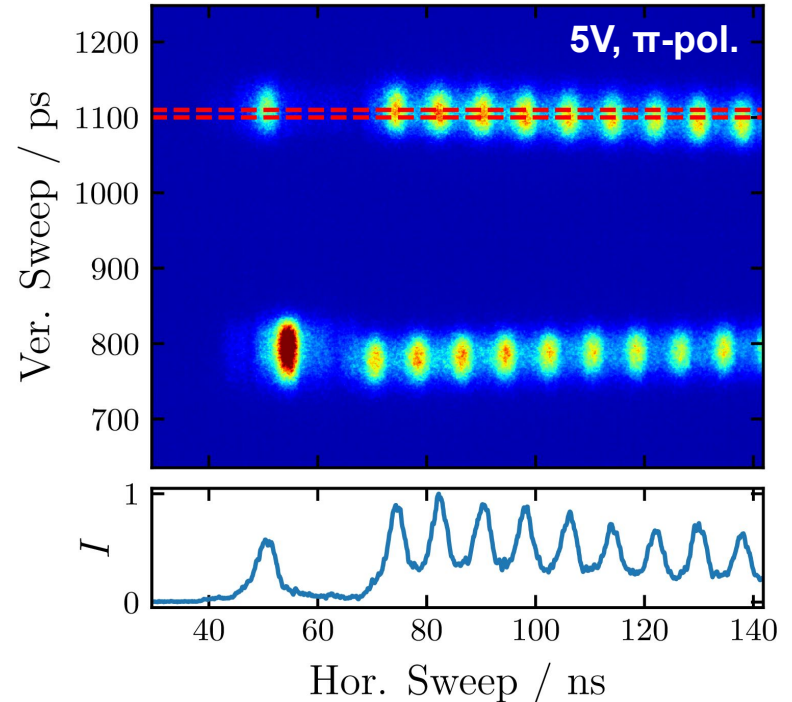
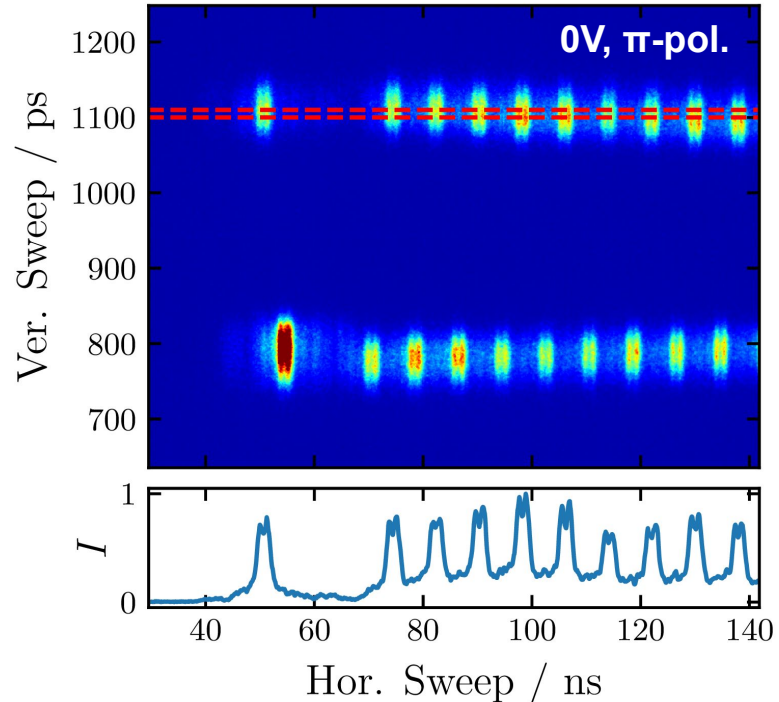
- Example: CCD camera image and projection for π -Polarisation @700nm
- Use the destructive interference dip in the center of imaged π -pol. synchrotron radiation to extract information about the vertical beam size



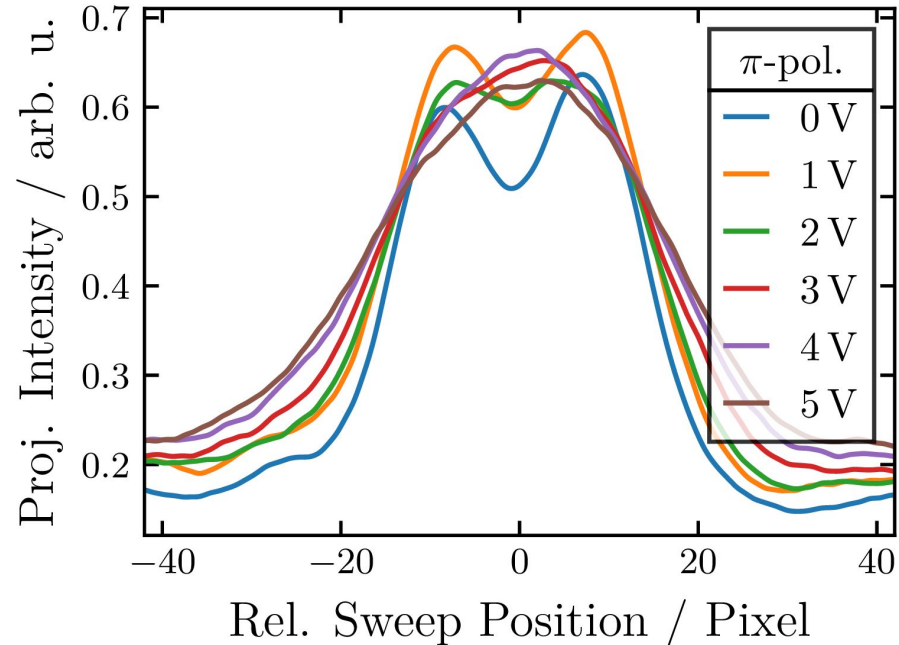
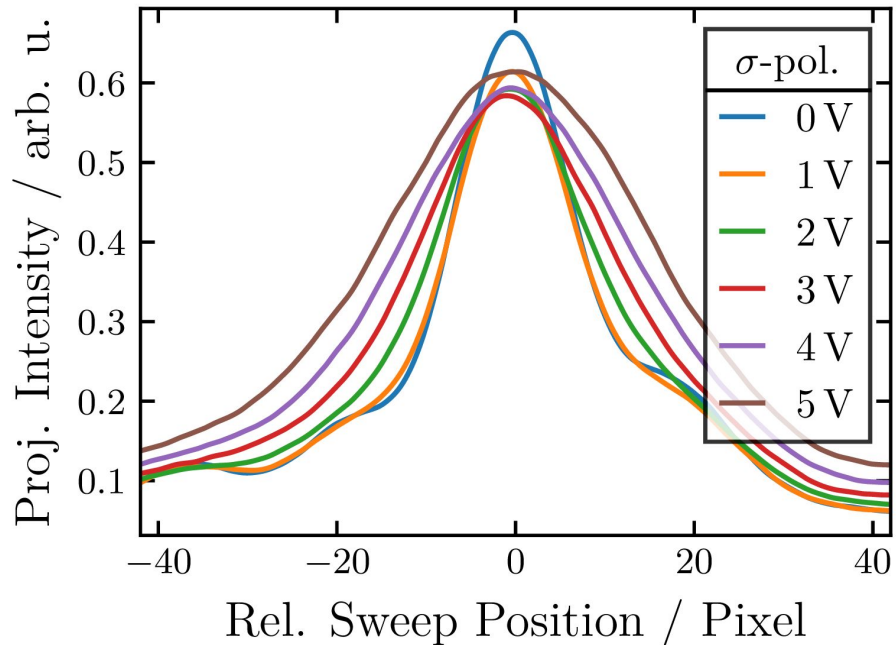
- Measurement with regular CCD (average over all bunches) @700nm
- Projections corresponding to vertical bunch direction for variable ver. beam size using white noise excitation (set values between 0V and 5V)



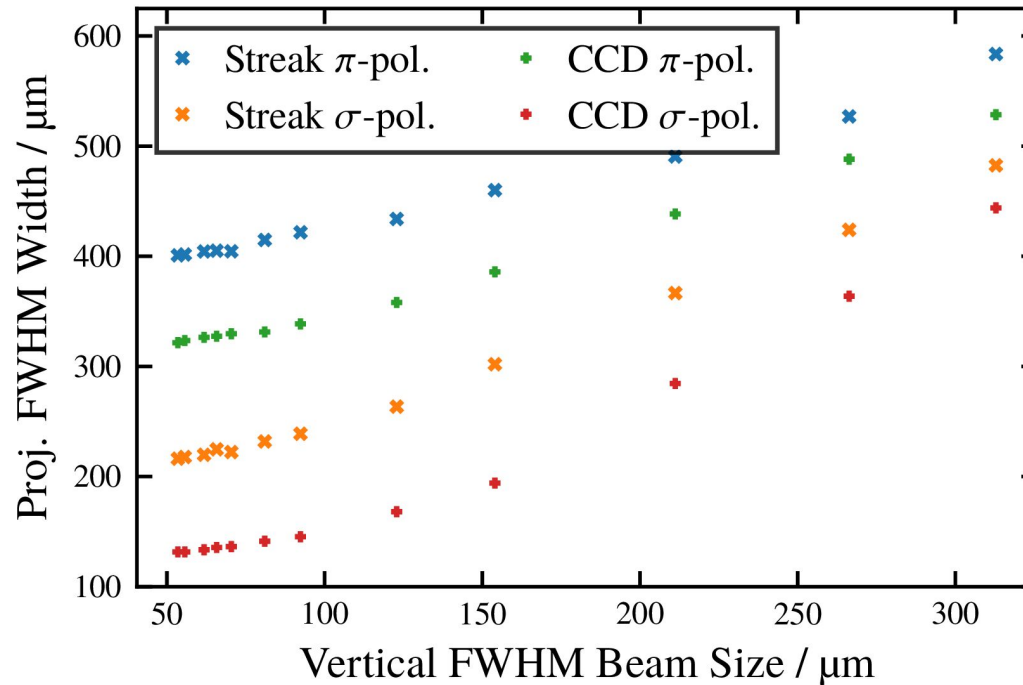
- Measurement with streak camera, π -polarisation @700nm
- Images for 0 and maximum excitation of vertical beam size



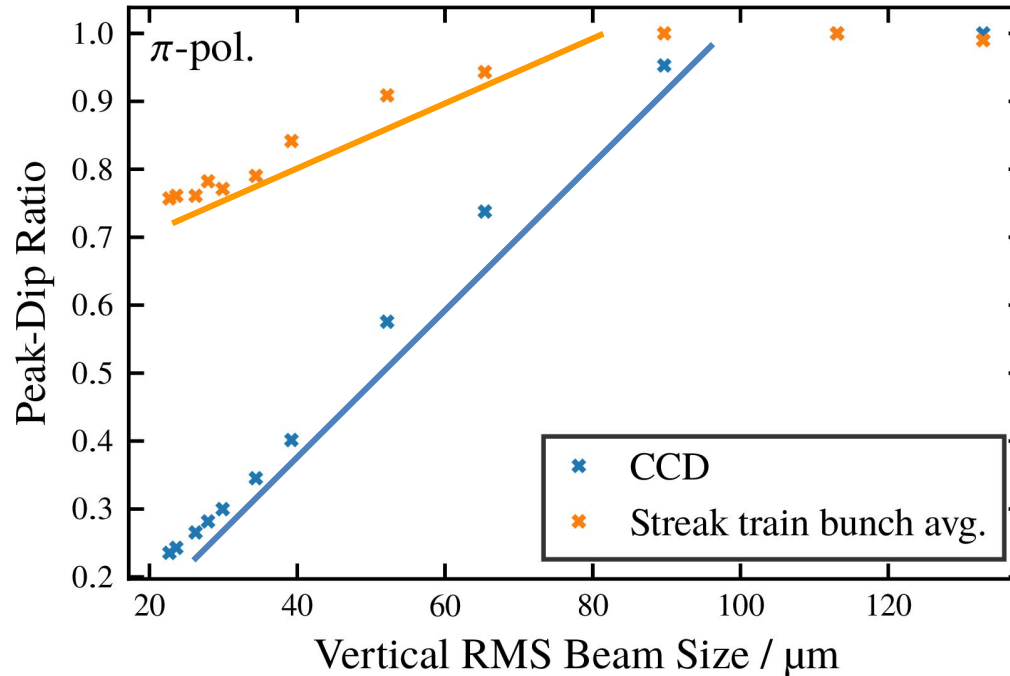
- Averaged train bunch projections corresponding to the vertical bunch direction measured for the different excitation (beam size) at streak camera (@700nm)



- FWHM of central (σ -pol) or two central (π -pol) peaks in the interference pattern (avg. train bunch) at CCD ($> 120 \mu\text{m}$) and Streak Camera ($> 215 \mu\text{m}$)
- Details can be understood from interference and resolution effects

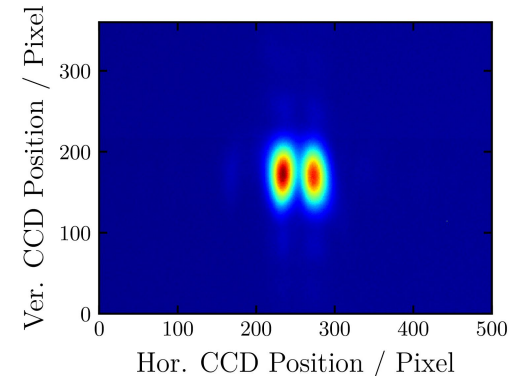
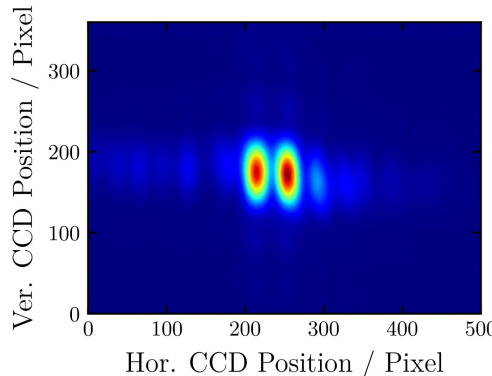


- Peak-Dip-Ratio (π -pol) vs. vertical beam size (train bunch)



- Streak Camera is sensible to RMS beam sizes below 90 μm

- Very good conditions to observe additional parameters in transverse dimension
- The combination of interferometric methods and the streak camera opens the detection range to RMS beam sizes below $90\ \mu\text{m}$ and 2D bunch-resolved measurements are possible at a resolution of about $10\ \mu\text{m}$ (RMS)
- Consistency in transforming projections gives reasonable streak camera point spread function
- Resolution (lens) and bunch separation (aperture at intermediate focus) at streak camera can be improved





Thank you for your attention!